

**AMENDMENTS TO THE SPECIFICATION:**

Please replace Paragraph [0011] with the following amended paragraph:

[0011] Another drawback in the employment of, for example, polyvinyl alcohol as barrier layer instead of aluminum foil is that, on storage of lightsensitive foods, it is necessary in many cases also to incorporate into the packaging material a light barrier of some type. Granted, a core layer of paper or paperboard does not (to the naked eye) allow the passage of any light, but light in invisible wavelength ranges nevertheless penetrates through from the outside of a packaging container to the packed food product and may have a negative effect on it from the point of view of shelflife. The employment of aluminum foil in the packaging material enjoys that advantage that the aluminum foil in itself constitutes a good barrier against both gases and against light. On the other hand, polyvinyl alcohol is as good as completely transparent even in mixtures with a hydrophobic polymer such as ethylene acrylic acid copolymer or styrene butadiene copolymer. The admixture of conventional light barriers, such as carbon black and titanium dioxide into any of the plastic layers included in the laminated packaging material according to W097/22536 is per se possible, but would entail an aesthetically unattractive appearance in the package.

Please replace Paragraph [0013] with the following amended paragraph:

[0013] As indicated above, PVOH has environmental benefits as a barrier material. In addition to such synthetic materials, the possibility of using natural and

biodegradable polymers (biopolymers) such as starch and starch derivatives, as gas barrier materials has been investigated.

Please replace Paragraph [0015] with the following amended paragraph:

[0016] From W097/16312 it is known that very thin layers of starch applied on to a core layer may provide some gas barrier properties, at least when employed together with an adjacent layer of plastics, which has been united with starch barrier layer by extrusion coating of the plastics material. Two very thin layers of starch, applied in a quantity of 0.5 and 1 g/M<sup>2</sup> respectively, dry weight, on to opposite sides of a core layer of paperboard and each extrusion coated with a layer of plastics, provided an oxygen gas barrier of 289 cm<sup>3</sup>/m<sup>2</sup>, per 24 h at 1 atm. Similarly, two layers of starch, applied in a quantity of 1 and 1.5 g/m<sup>2</sup> respectively, provided an oxygen gas barrier of 141 cm<sup>3</sup>/m<sup>2</sup>, per 24 h at 1 atm. The results obtained were thus, comparable with the gas barrier properties of, for example, a 12 µm thick film of oriented PET, thus representing a 'medium performance barrier' material.

Please replace Paragraph [0016] with the following amended paragraph:

[0016] The packaging laminate W097/16312 is, however, merely a medium performance gas barrier material. This means that it may only be used for packaging of liquid food products during short time periods of cool storage. It is not hitherto known in the prior art to produce packaging laminates having high performance gas barrier properties from starch or starch derivative barrier materials. It would be much more desirable to be able to provide packaging material having sufficient gas barrier properties for long time storage of liquid food products,

i.e. for extended shelf life (ESL) at cool storage or even for aseptic storage. Such desirable high performance oxygen gas barrier properties are in the order of about  $50 \text{ cm}^3/\text{m}^2$  at 24 h, 1 atm (23°C, 50% RH) or better, e.g. up to  $30 \text{ cm}^3/\text{m}^2$  at 24 h. 1 atm, i.e. oxygen gas barrier properties comparable to those of, for example, PVOH, EVOH (ethylene vinyl alcohol copolymer) or ~~polyamides~~ polyamides (PA) when employed at a thickness of the order of about  $5\mu\text{m}$ .

Please replace Paragraph [0018] with the following amended paragraph:

[0018] However, although the above gas barrier polymer materials are capable of providing good gas barrier properties in a[[.]] packaging laminate they are still oxygen-permeable to some degree, while a metal or glass material to be used in canning or bottling has an oxygen permeability of substantially zero. In order to improve the gas barrier properties still further, the polymer gas barrier material may be mixed with an inorganic laminar compound. Such a gas barrier resin composition is for example described in EP-A-590263, wherein excellent high level gas and moisture barrier properties are obtained. EP-A-590263 discloses a process for producing a gas barrier resin composition or its moulded article including a film, the composition comprising a resin and an inorganic laminar compound having a particle size of 5 having a particle size of 5  $\mu\text{m}$  or less and an aspect ratio of 50 to 5000, the process comprising dispersing the inorganic laminar compound in a resin or resin solution in the state that the inorganic laminar compound is swollen or cloven with a solvent/dispersant and removing the solvent from the dispersion, if necessary in the form of a film, while keeping the laminar compound in the swollen state.

Please replace Paragraph [0030] with the following amended paragraph:

**[0030]** The barrier layer is preferably applied on the carrier layer in an amount, depending on the kind of polymer, of approximately ~~0.5~~ 0.5 to 20 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, more preferably approximately 1-10 g/m<sup>2</sup>, based on dry weight. If the coated amount is too low, the gas barrier properties may be inferior, while if the amount is too high, there is a risk for an inflexible barrier layer and crack formation therein.

Please replace Paragraph [0032] with the following amended paragraph:

**[0032]** Said aqueous polymer dispersion or polymer solution applied as barrier layer may be dried and optionally cured at a web surface temperature of approximately 80 to 200 ~~°C~~ °C. For non-curing materials it is preferred to operate at a temperature of approximately 80 to 130 °C.

Please replace Paragraph [0033] with the following amended paragraph:

**[0033]** Most preferably, materials including PVOH and inorganic laminar compound are preferably first dried at web temperatures from 80 to 160 ~~°C~~ °C (preferably 140 to 160 °C) in a first step and are cured at web temperatures from 170 to 230 °C in a second stage resulting in an improved gas barrier at 80 % RH. Optionally, the carrier and barrier material may be cooled between the two steps.

Please replace Paragraph [0035] with the following amended paragraph:

**[0035]** Suitably, the polymer with functional carboxylic acid groups is selected from among ethylene acrylic copolymer and ethylene methacrylic acid ~~copolymer-s~~ copolymers or mixtures thereof.

Please replace Paragraph [0038] with the following amended paragraph:

**[0038]** Optionally, the barrier layer is first dried and is then heated to a higher temperature so that the dried barrier layer is cured at a temperature of up to 230 °C, preferably approximately about 170 °C. The high temperature curing may be of short duration, such as corresponding to web speeds normally used in the packaging laminate production.

Please replace Paragraph [0039] with the following amended paragraph:

**[0039]** The carrier layer may consist of paper or plastics or plastics coated paper and preferred materials are described below. When paper is employed it is preferably thin. In one option the carrier layer preferably consists of paper with a grammage of approximately 5-35 g/m<sup>2</sup>, e.g. 7-25 g/m<sup>2</sup>, more preferably approx. 10-20 g/m<sup>2</sup>.

Please replace Paragraph [0048] with the following amended paragraph:

**[0048]** A gas barrier layer including starch and inorganic laminar compound is preferably applied at a dry coating weight of from 0.5 to 5 g/m<sup>2</sup>, more preferably 0.5 to 3 g/m<sup>2</sup>, e.g. from 1.5 to 2 g/m<sup>2</sup>.

Please replace Paragraph [0051] with the following amended paragraph:

**[0051]** We have observed that when polyethylene is applied to a layer based on starch at a high temperature, e.g. over 200 °C, the gas barrier properties are improved and that under appropriate conditions can be made to reach or move

further into a high performance level. According to the invention, the preferred method of obtaining optimal properties is to apply the barrier composition based on starch or starch derivative not to a thick core layer as in W097/16312 but to a separate carrier. Suitably then, the gas barrier layer is carried by a carrier layer of paper or plastics.

Please replace Paragraph [0052] with the following amended paragraph:

**[0052]** When paper is employed it is preferably thin, e.g. said carrier layer may be of paper having a surface weight of from 5 to 35 g/m<sup>2</sup> , preferably from 10 to 25 [[g/M<sup>2</sup> -]] g/m<sup>2</sup>. The paper may also be coated beforehand with a layer of plastics.

Please replace Paragraph [0055] with the following amended paragraph:

**[0055]** The degree to which the surface is impervious may be measured by measuring surface adsorption, e.g. in Cobb units. ("Cobb" = g(water)/m<sup>2</sup> adsorbed on to the surface in 60 seconds exposure to liquid water). Adsorption of other liquids could be measured in an analogous method. The method of measuring Cobb adsorption is defined in SCAN P12-64 and in TAPPI T441. The surface adsorption of plastics is generally about 1 Cobb, whilst a smooth paper surface will generally have an adsorption of about 20 to 30 Cobb. Suitably, for use in the invention the substrate surface should have an adsorption of 50 Cobb or less, preferably an adsorption of ~~30~~ 30 Cobb or less, more preferably an adsorption of less than 20 Cobb or most preferably an adsorption of 10 Cobb or less, e.g. less than 5 Cobb.

Please replace Paragraph [0060] with the following amended paragraph:

**[0060]** In order to avoid cracks, punctures or deformations in the barrier composition layer of starch or starch derivative layer and inorganic laminar compound, it is preferred that the surface on to which it is applied is smooth, e.g. that the substrate surface has a smoothness of 200 ~~Bendtsen~~ Bendtsen or better (i.e. less ), e.g. from up to 150 Bendtsen, most preferably up to about 100 Bendtsen.

Please replace Paragraph [0082] with the following amended Paragraph:

**[0082]** Where a composition of PVOH and inorganic laminar compound is used, the carrier layer 11 preferably consists of a layer of thin paper with a grammage of approx. 5-35 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, preferably 7-25 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, more preferably 10-20 g/m<sup>2</sup>, but may also be a plastics film. However, thin paper enjoys the advantage that it does not alter dimensions on temperature increases in connection with drying and possible curing, which does not apply to plastic. Generally, where the polymer applied is to be cured at above about 130 °C, the use of plastics film as carrier layer is not recommended.

Please replace Paragraph [0088] with the following amended paragraph:

**[0088]** The web of carrier layer 11 is led, after coating, further past a drying apparatus 15, e.g. an IR drier or a hot air drier which acts on the coated side of the carrier layer 11 for driving off water and drying the applied barrier layer 14 at a web surface temperature of approx. ~~80-100°C~~ 80-100 °C, preferably approx. ~~90-95°C~~ 90-95 °C, and, where applicable, a curing temperature for cross-linking the functional

groups included in the coated polymer mixture, a web surface temperature of up to approx. ~~490°C~~ 190 °C, preferably ~~470°C~~ 170 °C.

Please replace Paragraph [0090] with the following amended paragraph:

**[0090]** The carrier layer 11 with the applied barrier layer 14 may ideally be employed for the production of packaging material 10 in a corresponding manner and using corresponding production equipment to that employed in the production of packaging material with aluminum foil as the barrier layer. Fig. 2 shows a web of a configurationally rigid but foldable core layer with a grammage of approx. 100-500 g/m<sup>2</sup>, preferably approx. 200-300 g/m<sup>2</sup>, which may be a conventional fibre fiber layer of paper or paperboard of suitable packaging qualities. The core layer 16 is led through the ~~nip~~ nip between two rotating rollers 17 and is united with a web of carrier layer 11 with dried or cured barrier layer 14, during the application – employing an extruder 18 – of one or more layers of extrudable thermoplastic 19, preferably polyethylene, between the core layer 16 and the carrier layer 11. As shown, the barrier material 14 is preferably for the outer face of the carrier layer but it may alternatively be on the inner face.

Please replace Paragraph [0094] with the following amended paragraph:

**[0094]** From the laminated packaging material according to the present invention, liquid-tight, dimensionally stable packages possessing superior oxygen gas barrier properties may be produced employing known packaging and filling machines which, in a continuous ~~process~~ process form, fill and seal the material into



finished packages 50. An example of such a conventional, packaging container 50 is shown in Fig. 4.

Please replace Paragraph **[00100]** with the following amended paragraph:

**[00100]** From the drying station the dried web, having an upper layer 14 of starch and inorganic laminar compound, is led further to an extruder station at 23a at which the web and barrier layer is further laminated to a layer of plastics 21. The lamination of the starch surface to the plastics layer is carried out by means of surface fusion between the plastics layer and the layer including starch 14, which is obtained by simultaneous application of heat and the plastics. Preferably, molten polymer is extruded on to the dried starch layer at the same time as the web is led through the nip between two rotary cooling rollers 24a, thus forming a finished packaging laminate providing the upper three layers of the packaging laminate 10a as shown by a cross-section view in Figure 5a, having an outer layer of plastics 21, laminated to the starch layer 14. The extruded plastics material is (preferably) a thermoplastic polymer, preferably a polyethylene and most preferably LDPE, which enables efficient conversion of the packaging laminate 10a into liquid-tight, dimensionally stable packages by heat sealing. The extrusion temperature should be at least 200°C, preferably from about ~~250°C~~ 250 °C to about ~~330°C~~ 330 °C.

Please replace Paragraph **[00101]** with the following amended paragraph:

**[00101]** Alternatively, said surface fusion between the starch layer 14 and the plastic layer 21 may be obtained by laminating a pre-manufactured film of thermoplastic to the dried starch layer 14 by means of simultaneous application of

heat and pressure, preferably by means of leading the starch coated substrate and the plastic film together through a hot roller nip, whereby the temperature supplied by the hot rollers is at least ~~200°C~~ 200°C and up to about ~~350°C~~ 350 °C, preferably from about 250°C to about 330°C.

Please replace Paragraph [00107] with the following amended paragraph:

**[00107]** An aqueous composition including PVOH and an inorganic laminar compound is preferably applied in such a quantity that the applied and dried starch layers 14, 14' each have a thickness/surface weight of from about 1 to about 10 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>.

Please replace Paragraph [00108] with the following amended paragraph:

**[00108]** The web coated with aqueous solution is led further to a drying station 15b at which the web is dried with the aid of a drying apparatus for removing water from the applied layers of aqueous starch solution. Preferably, drying takes place at a temperature of about ~~[[.]]~~ 80-100°C, as described above. Optionally, the dried barrier layer is then cured at a higher temperature as described above.

Please replace Paragraph [00111] with the following amended paragraph:

**[00111]** A paper or paperboard core layer for use in the invention usually has a thickness of from about 100 pm up to about 400 pm, and a surface weight of approximately 100-500 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, preferably about 200-300 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>.

Please replace Paragraph [00114] with the following amended paragraph:

**[00114]** Suitable thermoplastics for the outer layer 14 are polyolefins, preferably polyethylenes and most preferably low density polyethylenes such as, for example LDPE, linear LDPE (LLDPE) or single site catalyst metallocene polyethylenes (m-PE). The outer layer 22, which eventually will form the outside of the packaging container manufactured from the packaging laminate, may alternatively be applied on to the core web 16 in a step before the coating ~~and drying~~ and drying steps of the barrier composition.

Please replace Paragraph **[00120]** with the following amended paragraph:

**[00120]** Using the methods and materials described above by applying an aqueous barrier composition comprising a dispersion/solution of starch or a derivative and an inorganic laminar compound on to a substrate layer for supporting the barrier layer, which consists of a specifically chosen material, in combination with subsequent drying and lamination to a layer of plastics by heat fusion of the plastics surface, highly improved oxygen gas barrier properties are obtained in packaging laminates compared to those of W097/16312. The improvement in the gas barrier properties of the laminated barrier layer has been improved radically into an excellent so called high performance barrier layer. The best gas barrier results have been obtained when the substrate layer consists of a polymer or has a polymer coated surface, but also a thin paper layer having a surface weight of approximately 7-35 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup> with smooth, essentially non-absorbing surfaces, will provide improved gas barrier properties compared to those previously known in connection with compositions including starch.

Please replace Paragraph [00122] with the following amended paragraph:

**[00122]** A starch-containing gas barrier layer according to the invention is advantageously applied in an amount of from about 0.5 to 5 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, dry weight. At amounts lower than 0.5 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, the tolerances of the layer thickness as well as the gas barrier properties will become less reliable. On the other hand, at amounts exceeding about 3 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, the risks that the starch-based barrier layer may become brittle and inflexible will increase. However, amounts applied of up to about 5 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>, dry weight, are possible and for some type of packages and uses even higher amounts might be acceptable. The gas barrier property of the starch-composition layer generally improves with increasing thickness. The optimal and preferred applied amount of starch ranges from about 1.5 to about 2 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup>.

Please replace Paragraph [00124] with the following amended paragraph:

**[00124]** An aqueous dispersion of from about 1-5 weight % exfoliated flake shaped mineral particles (natural, e.g. Montmorillonite, or synthetic, e.g. Laponite) having an aspect ratio of about 50-5000, is blended with an aqueous solution of ~~about~~ about 5-30 weight % of PVOH (having a molecular weight of 16000-200000 g/mol and a saponification degree of 95-100 %) at 60-90 °C during 2-8 hours. The dispersion of exfoliated laminar mineral particles may be stabilised by means of a stabiliser additive. Alternatively, the laminar mineral particles are exfoliated in the PVOH-solution at 60-90 °C during 2-8 hours. Aqueous ethylene acrylic acid copolymer dispersion is added to the aqueous mixture of PVOH and mineral particles. The resulting mixture is dispersion coated by from about 1 to about 10 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup> based on dry coating weight onto a thin plastic coated paper carrier layer.

The wet coating is applied as a solution/dispersion in water and dried at a web surface temperature of ~~100-150°C~~ 100-150 °C followed by curing at 170-190 °C.

Please replace Paragraph [00126] with the following amended paragraph:

[00126] In preparing the barrier material/carrier material element, starch was prepared for use in coating from a dry powder state by ~~mixing~~ mixing 10 wt% of starch with water at ambient temperature to form a slurry.

Please replace Paragraph [00127] with the following amended paragraph:

[00127] An aqueous dispersion of from about 1-5 weight % exfoliated flake shaped mineral particles (natural, e.g. Montmorillonite, or synthetic, e.g. Laponite) having an aspect ratio of. about 50-5000, is blended with the aqueous solution/dispersion of starch at 60-90°C during 2-8 hours. The dispersion of exfoliated laminar mineral particles may be stabilised by means of a stabiliser additive. Alternatively, the laminar mineral particles are exfoliated in the starch slurry at ~~60-90°C~~ 60-90 °C during 2-8 hours.

Please replace Paragraph [00132] with the following amended paragraph:

[00132] Preferably, the dried starch layer was extrusion coated with LDPE. About 25 ~~g/m<sup>2</sup>~~ g/m<sup>2</sup> of LDPE was extruded on to the dried starch, layer at about 200 m/minute, 325°C, cooling roller at 10-15°C, as above. The distance between the extrusion die to the web was normally 10-30 cm. The extruded LDPE hit the web just before entering between the cooling roller and the counter pressure roller.